International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 3, March 2017, pp. 670–679 Article ID: IJCIET_08_03_067
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

COMPARITIVE ANALYSIS AND DESIGN FOR PRECAST AND RCC EWS BUILDINGS

Mohini V. Patel
M.E Structures, Civil Department,
KJ College of Engineering & Management Research
Kondhwa Saswad Road, Near Bopdeo Ghat, Pune 411048.

A.B.Pujari
Assistant Professor
KJ College of Engineering & Management Research
Kondhwa Saswad Road, Near Bopdeo Ghat, Pune 411048.

ABSTRACT

This paper investigates that how the precast technology will be helpful for the country like India where the more population is present. For this situation providing the shelter to all economical weaker section people the precast technology will be helpful. To Indian government to provide the shelter to all people and with optimum cost of construction the precast will be preferable. With the help of etabs software we analyzed the both rcc and precast structure for structural stability and have checked for all the different conditions and which gave the satisfactory results for the structures.

Key words: Precast, RCC, EWS, ETABS, Linaer Static and Dynamic Analysis.

Cite this Article: Mohini V. Patel and A.B.Pujari, Comparative Analysis and Design For Precast and RCC EWS Buildings. International Journal of Civil Engineering and Technology, 8(3), 2017, pp. 670–679.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3

1. INTRODUCTION

The face of realty market in India has changed rapidly over the past few years. The large projects comprising of Townships Mass Housings, IT/ITES parks and SEZs' are of common occurrence these days and will only grow exponentially in the near future. Majority of such projects are still being constructed using the conventional methods. Thus the inherent advantage that these projects offer in terms of repetitions and huge volume turnover remain unexploited. In addition, these large scale projects constructed using conventional methods complicates the Project Management in terms of speed and quality of the construction.

India is a growing economy. It is estimated to be the third largest economy by 2050 [13] and also India's urban population registered a decadal growth of 32 percent, rising from 285

million to 377 million between 2001 and 2011 and the pace of growth is likely to be increased in future. Given this scenario, it becomes critical to fill the existing gaps in the country's strained urban infrastructure and in particular, housing. As on 2012 India face shortage of 18.68 million households primarily, it would be important to address the need in the EWS (Economically Weaker Sections with annual income less than Rs 90,000) and LIG (Lower Income Groups with annual income less than Rs 1,20,000), which currently account for 95 percent of urban housing shortage in the country [10]. Despite so much of shortage in requirements of units of constructions, why precast construction technology has not penetrated into housing sectors, while it is very well developed and used in infrastructure projects.

Table 1

Criterion	EWS	LIG	LMIG	MIG
Carpet area in m2	25	40	60	80
Super-built-up/	32.5	52	78	104
Monthly income	7500	10000 (average)	20000	25000
Annual Income	90000	120000	240000	300000
Criterion	EWS	LIG	LMIG	MIG
Maximum Loan	300000	450000	1000000	1500000
EMI*	2700	4000	NA	NA

Urbanization in India has generated huge demand for housing which neither the cities nor the housing sector is prepared for. The number of urban agglomerations has increased from 384 in 2001 to 475 in 2011, a decadal increase of 23.7%. As per the twelfth five-year plan (2012-17) the total housing shortage in rural areas is 43.66 million units. In order to cater the issue surrounds the shortage of affordable and low cost mass housing at a much competitive cost and on time schedule, it is imperative to adopt alternative construction system. The Indian construction industry led by traditional mode of construction as characterized by challenges such as low productivity, lack of skilled labor, time and cost overruns etc. Precast Concrete Construction, the so called unconventional method in Indian Construction Industry can cater the above needs by offering both speed and quality of the construction.

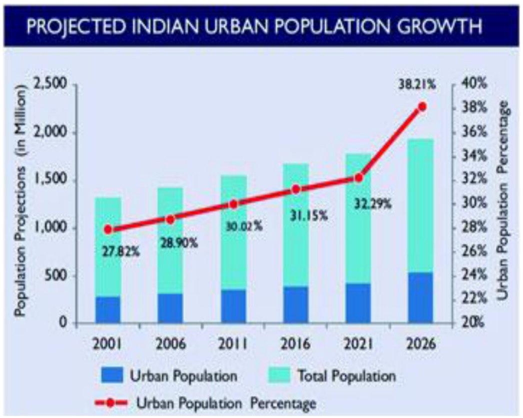


Figure1 India Urban Population Growth

Precast Building Technology in India is facing various challenges due to lack of awareness of advantages of precast, resistance to change, lack of expertise, lack of guidance, information and an assumption that precast is costly proposition in contrast to conventional without bearing in the mind the overall benefits associated with it and one of the fact that construction industry is not yet shifted to standardization. With the changing face of realty

sector in Indian market, the change of construction methodology from conventional to precast building construction is anticipated. India's geographical position poses challenges to the construction industry. Seismic activity is the most worrying natural threat the building industry has to take into careful consideration to which precast industry offers solutions that have been widely tested in real conditions. The rainy season lasts for four months, creating additional challenges for the building project management. Precast parts can be manufactured in surroundings where the effects of rain and other weather conditions can be eliminated. Precast technology has been proven to be a good solution for work safety. Like many other countries, India is also facing a shortage of skilled labor in the building industry. Precast is less labor-intensive. An additional advantage of precast is that during manufacturing and installation similar work-routines are repeated. This helps workers to learn and become more efficient, project after project. There are some perceptions that precast construction is inflexible with respect to changes and upkeep of the work. But when we consider L&T's Pragati, Architectural features were customized as per the requirement of client. Also Aesthetic value of the project is enhanced because of the variety of colors and architectural finishes possible in precast concrete.

Table 2 Advantages and Disadvantages

Advantages	Disadvantages
High Quality	Large Initial Investment
Fast Construction	Heavy lifting equipment required Reduction in manpower
Longer Preparation time required Less wastage and safety standards	Transportation of Precast Elements Good Health Taxation
Durable construction material	Limited Flexibility
Large floor spans possible	Large storage stock yard required

2. METHODOLOGY

2.1. Linear static analysis

In the linear relation of stress-strain of a material, Hooke's law is valid for small stress-strain range. For linear elastic analysis, sets of loads acting simultaneously can be evaluated by superimposing (adding) the forces or displacements at the particular point.

Static analysis mainly used for bridges under dead load, vehicular load, wind load and thermal effects. The influence of plan geometry has an important role in static analysis (AASHTO 4.6.1). One should pay attention to plan aspect ratio and structures curved in plan for static analysis.

It is used to estimate seismic demands for ordinary bridge structures as specified in Caltrans SDC (Caltrans, 2013). A bridge is usually modeled as Single-Degree-of Freedom (SDOF) and seismic load applied as equivalent static horizontal force. It is suitable for individual frames with well-balanced spans and stiffness. Caltrans SDC (Caltrans, 2013) recommends stand-alone "Local" Analysis in Transverse & Longitudinal direction for demands assessment. Figure 4.3-1 shows a stand-alone model with lumped masses at columns, rigid body rotation, and half span mass at adjacent columns. Types of Equivalent Static Analysis such as Lollipop Method, Uniform Load Method and Generalized Coordinate Method can be used.

Static analysis, static projection, and static scoring are terms for simplified analysis wherein the effect of an immediate change to a system is calculated without respect to the longer term response of the system to that change. Such analysis typically produces poor correlation to empirical results.

2.2. Linear dynamic analysis

Structural analysis is mainly concerned with finding out the behavior of a physical structure when subjected to force. This action can be in the form of load due to the weight of things such as people, furniture, wind, snow, etc. or some other kind of excitation such as an earthquake, shaking of the ground due to a blast nearby, etc. In essence all these loads are dynamic, including the self-weight of the structure because at some point in time these loads were not there. The distinction is made between the dynamic and the static analysis on the basis of whether the applied action has enough acceleration in comparison to the structure's natural frequency. If a load is applied sufficiently slowly, the inertia forces (Newton's second law of motion) can be ignored and the analysis can be simplified as static analysis. Structural dynamics, therefore, is a type of structural analysis which covers the behavior of structures subjected to dynamic (actions having high acceleration) loading. Dynamic loads include people, wind, waves, traffic, earthquakes, and blasts. Any structure can be subjected to dynamic loading. Dynamic analysis can be used to find dynamic displacements, time history, and modal analysis.

A dynamic analysis is also related to the inertia forces developed by a structure when it is excited by means of dynamic loads applied suddenly (e.g., wind blasts, explosion, and earthquake).

A static load is one which varies very slowly. A dynamic load is one which changes with time fairly quickly in comparison to the structure's natural frequency. If it changes slowly, the structure's response may be determined with static analysis, but if it varies quickly (relative to the structure's ability to respond), the response must be determined with a dynamic analysis. Dynamic analysis for simple structures can be carried out manually, but for complex structures finite element analysis can be used to calculate the mode shapes and frequencies.

The most general approach for the solution of the dynamic response of structural Systems is the direct numerical integration of the dynamic equilibrium equations. This involves, after the solution is defined at time zero, the attempt to satisfy dynamic equilibrium at discrete points in time. Most methods use equal time intervals at D t, 2Dt, 3Dt........NDt. Many different numerical techniques have previously been presented; however, all approaches can fundamentally be classified as either explicit or implicit integration methods. Explicit methods do not involve the solution of a set of linear equations at each step. Basically, these methods use the differential equation at time “t” to predict a solution at time “t+Dt”. For most real structures, which contain stiff elements, a very small time step is required in order to obtain a stable solution. Therefore, all explicit methods are conditionally stable with respect to the size of the time step. Implicit methods attempt to satisfy the differential equation at time “t” after the solution at time “t-Dt” is found. These methods require the solution of a set of linear equations at each time step; however, larger time steps may be used. Implicit methods can be conditionally or unconditionally stable. There exist a large number of accurate, higher-order, multi-step methods that have been developed for the numerical solution of differential equations. These multistep methods assume that the solution is a smooth function in which the higher derivatives are continuous. The exact solution of many nonlinear structures requires that the accelerations, the second derivative of the displacements, are not smooth functions. This discontinuity of the acceleration is caused by

the nonlinear hysteresis of most structural materials, contact between parts of the structure, and buckling of elements.

3. ETABS MODELLING

It is proposed to construct the peenya housing at, Pune being developed using precast wall panels & precast solid floor slabs.

Design Criterion

Reinforced Concrete Members as per IS 456:2000

Prestressed Concrete Floors as class 2 members as per IS 1343:1980

Structural Steel members as per IS 800:1984

Connections of Precast Elements as per IS 11447:1985

Design Loads:

1. Dead Loads
   - The Dead Loads are calculated based on unit weights as per IS 875-1
2. Live Loads
   - The Imposed Loads are based on IS 875 part 2
   - Residential Rooms = 2.0 kN/sqm
   - Stairs, Lobbies & Balcony = 3.0 kN/sqm
   - Lift Machine Room = 10.0 kN/sqm
3. Wind Loads
   - The Wind Loads are calculated based on IS 875 part3
   - Basic Wind Speed of 33m/s
   - Return Period of 50 years
   - Terrain Category 2 (Open Terrain with well scattered obstructions)
   - Structure Size Class B
   - Topographical Features Insignificant
4. Seismic Forces
   - The Seismic Forces are calculated based on IS 1893 part 1:2002
   - Zone Factor of 0.1 (Zone II - low)
   - Response Reduction Factor of 3
   - (Ordinary reinforced concrete shear walls)
   - Importance Factor of 1.0

The Founding Strata is assumed as hard soil (Refer Annex B) Damping of structure 5%

5. Load Combinations
   - 1.5*DL + 1.5*LL
   - 1.5*DL +or- 1.5*EL
   - 1.2*DL + 1.2*LL +or- 1.2*EL
   - 0.9*DL +or- 1.5*EL

- 1.5*DL +or- 1.5*WL
- 1.2*DL + 1.2*LL +or- 1.2*WL
- 0.9*DL +or- 1.5*WL

1. Vertical Deflection

The Final Deflection due to full load shall not exceed L/250
The Deflection before applying finishes shall not exceed L/350

2. Lateral Sway

The Lateral sway due to wind loads shall not exceed H/500 the storey drift at any floor shall not exceed 0.004 times the storey height under design seismic force (working)

The secondary effects (P-Delta analysis) should be considered if Q as defined in E-2 of IS 456 exceeds 0.04

3. Fire resistance

A structure or structural element required to have fire resistance should be designed to possess an appropriate degree of resistance to flame penetration; heat transmission and failure. The fire resistance of a structural element is expressed in terms of time in hours in accordance with IS 1641. Fire resistance of concrete elements depends upon details of member size, cover to steel reinforcement detailing and type of aggregate (normal weight or light weight) used in concrete.

Structure is design for fire rating of 2 hr. referring figure1 page no.34 of IS 456:2000

As the125 mm wall with single mesh at the center is consider for 2hr of fire rating

Concrete

- Ground Floor shear walls Concrete of Grade M40
- shear walls: Precast Concrete of M40 (all floors)
- Flooring slabs: Precast Concrete of M40 (all floors)
- Insitu Stitches at Junction: Insitu Concrete of M45 (Pumpable)
- Reinforcement
- Raft/Pile Foundation: Fe500 of HYSD/TMT bars
- Ground Floor shear walls: Fe500 of HYSD/TMT Bars
- Superstructure shear walls: Fe500 of HYSD/TMT Bars
- Structural Screed: Fe500 of HYSD/TMT Bars
- Fe500 of Welded Wire Mesh

Groute
Joints: Non-Metallic, Non-Shrink with 70 Mpa strength at 28 days

4. CALCULATIONS

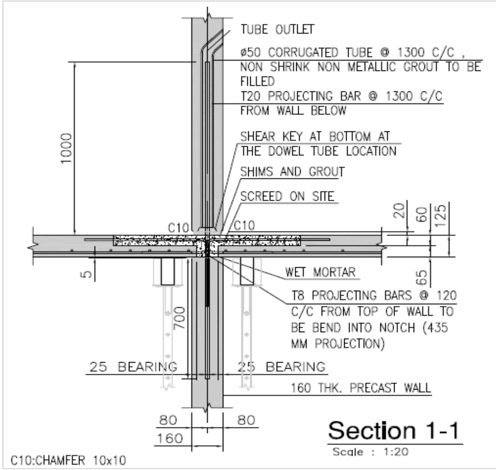
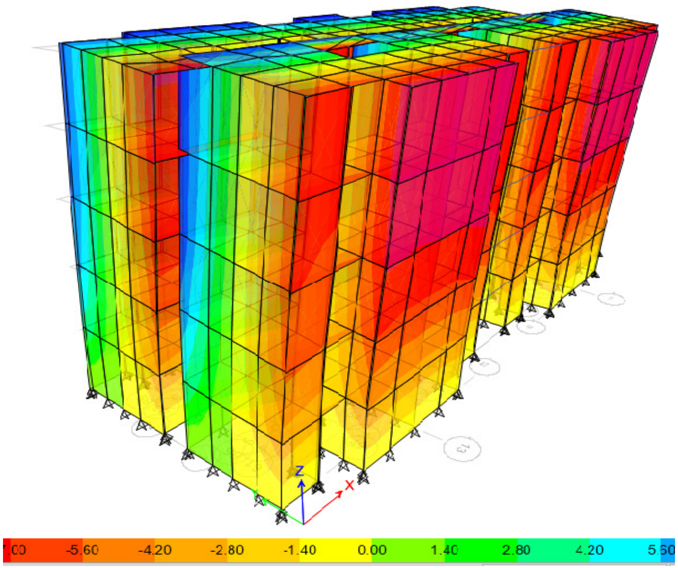


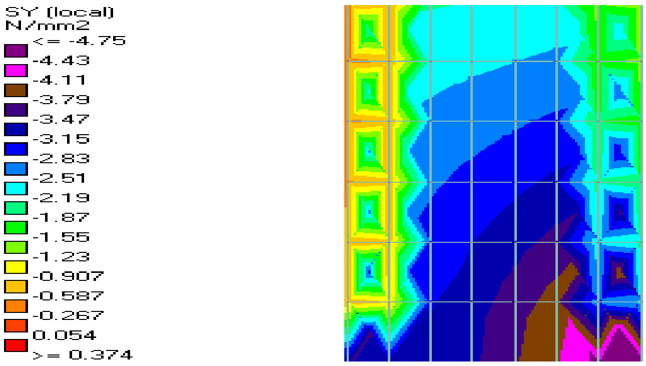
Figure 2 Typical Connection Details

Summary of Gravity Loads		
Location	***Dead Load***	***Live Load***
Roof	5.125 Kn/sqm	2.0 Kn/sqm
Typical Floor (Rooms)	5.125 Kn/sqm	2.0 Kn/sqm
Lobby	4.625 Kn/sqm	3.0 Kn/sqm
Stairs	6.625 Kn/sqm	3.0 Kn/sqm
Lift Machine Room	3.75 Kn/sqm	10.0 Kn/sqm
OHWT	1700Kn	-

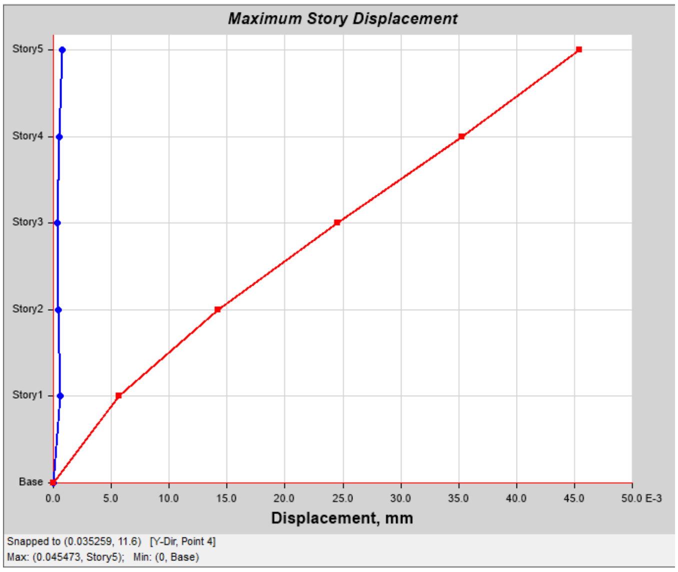
Wind calculation



Wall calculations



Stresses in Wall (Worst Case for Z direction)



5. RESULT AND CONCUTIONS

According to Etabs analysis the deflections values for Rcc and Precast structures are shown in following graphical way. For Rcc structure deflection is about 50x10-3mm and for precast is 27x10-3mm.

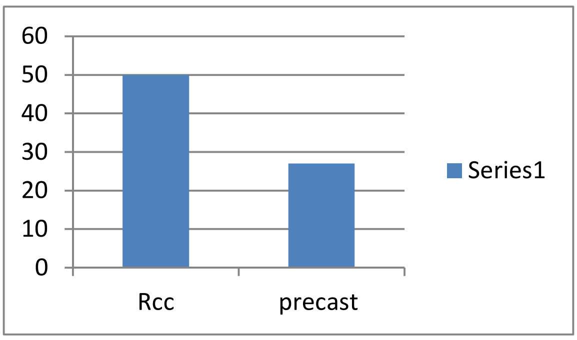


Figure 3 Max deflection Rcc and Precast Building

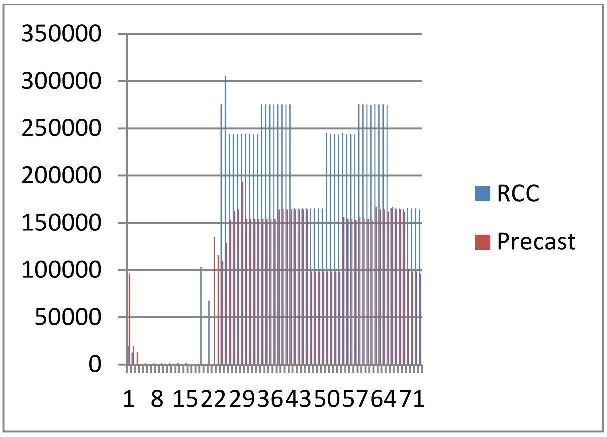


Figure 4 Resultant bending moments in Nmm for Rcc and Precast building

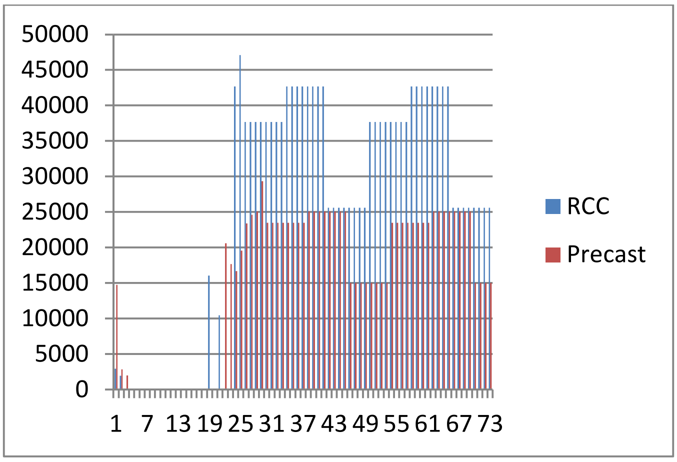


Figure 5 Resultant shear forces in N for Rcc and precast building

According to the results from the etabs for both rcc and precast both the structures are structurally stable. But for life span the precast will be more preferable as well as according to cost of construction and time precast will be more preferable for EWS projects which are maximum time repetitive which will more helpful for Indian government.

In terms of structural points like shear forces and bending moments for precast structure is more resistant than rcc structures. And keeping in mind about the Indian population and the construction industry for ews category the precast will be more useful for Indian government to save the construction cost and time with maintaining the good quality in structures.

6. ACKNOWLEDGMENT

Words are in adequate to express my deep sense of gratitude to Prof. A.B.Pujari, My Guide for his consistent guidance & inspiration throughout the seminar work.

I owe sincere thanks, more than what I can express, towards Prof. S.K. Patil, Head of Civil Engineering Dept. KJCOEMR, Pune. As all the success is the result of his affectionate encouragement. I am grateful to my Principal Dr. S. J. WAGH for his encouragement and guidance throughout the masters of engineering course. I specially thank to Prof. A.B.Pujari for inspiring guidance and timely cooperation. I am expressing my sincere thanks to all the staff and colleagues who have helped me directly or indirectly in completing this project.

REFERENCES

[1] Newmark, N .M, “ A Method of Computation for Structural Dynamics”, ACSE JOURNAL OF ENGINEERING Vol.85 No Em3,(1959)

[2] Ductility damage indices based on seismic performance of RC framesSoil Dynamics and Earthquake Engineering, Volume 77, October 2015, Pages 226-237

[3] Static pushover versus dynamic collapse analysis of RC buildings Engineering Structures, Volume 23, Issue 5, May 2001, Pages 407-424

[4] Modelling and nonlinear static analysis of reinforced concrete framed buildings irregular in plan Engineering Structures, Volume 80, 1 December 2014, Pages 98-108

[5] PCI design handbook, precast & prestressed concrete 7th Edition.

[6] ACI 550.1R01 Emulating cast in place detailing in precast concrete structures.

[7] State – of – art FIB 43, Structural connections for precast concrete buildings.

[8] IS: 15916 – 2010Code of Practice for Building Design and Erection using Prefabricated Concrete, Bureau of Indian Standards.

[9] Mohd. Mohsin Khan and Dr. Amrit Kumar Roy, CFD Simulation of Wind Effects on Industrial RCC Chimney. International Journal of Civil Engineering andTechnology, 8(1), 2017, pp. 1008–1020.3

[10] Bhavin H. Zaveri, Bhargav K.Panchotiya, Smit U. Patel and Pratik A. Bilimoria. Parametric Study of RCC, Steel and Composite Structures Under Seismic Loading. International Journal of Civil Engineering and Technology, 7(4), 2016, pp.127–147.

[11] A.K. Sinha and Sharad Singh, Structural Response Control of RCC Moment Resisting Frame Using Fluid Viscous Dampers. International Journal of Civil Engineering andTechnology, 8(1), 2017, pp. 900–910

[12] IS: 11447 – 1985Code of Practice for Construction with Large Panel Prefabricates, Bureau of Indian Standards.

[13] Senou K., “Need for Precast Technology and its Influence on Residential Building Construction,” Zak Precast Concrete India Conference, September 2013.